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# Gibraltar Farm, Ham Lane, Hempstead, Gillingham, Kent

## Flood Risk Assessment

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| Revision | Amendment Details | Revision Prepared By | Revision Approved By |
|---|---|---|---|
| | | | |

## EXECUTIVE SUMMARY

I This Flood Risk Assessment report has been prepared to support an outline planning application for up to 450 dwellings. It considers the development proposals in the context of all sources of flooding, and assesses the impact of surface and foul water drainage proposals (including climate change) and provides appropriate mitigation measures to inform the detailed design of the scheme and ensure safe operation of the site for the lifetime of the development.

II The site lies wholly within fluvial Flood Zone 1 (the lowest flood risk category). No surface watercourses cross the site or are present in the surrounding area. A dry valley passing through the site from the central western boundary to the northern boundary is noted to have a predominantly 'low' risk of surface water flooding with some localised areas at 'medium' risk. Otherwise no additional sources of flooding were identified.

III A new separate foul and surface water drainage network is proposed to serve the development.

IV Foul drainage is to be arranged such that the development drains by gravity to a new adoptable foul water pumping station to be constructed in the northern part of the site. This will then pump flows to the Southern Water foul water network within North Dane Way as agreed with Southern Water Developer Services via a pre-development enquiry.

V Due to the lack of surface watercourses and surface water sewers at a suitable level within the vicinity of the site, intrusive investigations were carried out in both the shallow and deep geology to ascertain the potential for infiltration systems. These investigations found good infiltration potential throughout, however due to the poor structural integrity of the shallow deposits it is proposed to drain surface water from the development to a series of deep borehole soakaways placed within attenuation basins which have been sized to accommodate the design 1 in 100 year rainfall event with an allowance for climate change.

VI Pollution prevention measures will be incorporated throughout the scheme to minimise the risk of groundwater contamination in line with the available Environment Agency guidance. These will include tanked permeable paving, swales, filter strips and appropriate design of boreholes.

VII The drainage proposals are in line with Environment Agency requirements and pose no issues that would prevent the safe development of the site. This report identifies that subject to mitigation measures for residual risks there are no flood risk issues that would prevent the proposed residential development at Gibraltar Farm from being brought forward as currently proposed.

# 1.0 INTRODUCTION

## Brief

1.1 Create Consulting Engineers Ltd was instructed by K.D, S.J & M.C Attwood (the Client) to undertake a Flood Risk Assessment (FRA) for Gibraltar Farm, Ham Lane, Hempstead, Gillingham, Kent.

## Project Context

1.2 The site has an area of 23.6 hectares (ha) comprising agricultural land to the south of Gillingham, Kent. The Client intends to submit a planning application for up to 450 residential units on this land with an access from North Dane Way.

1.3 The site location plan is included on Drawing 630/00/001B, whilst an existing site layout is shown on Drawings 1064-SURV-001 Sheets 1-4.

1.4 An indicative masterplan is shown on Drawing EDP 1995/77c.

## Planning Policy Context

1.5 The potential consequences of inappropriate development in a flood risk area for occupiers, either of the development or elsewhere, pose significant risks in terms of personal safety and damage to property.

1.6 The National Planning Policy Framework (DCLG, 2012a) includes government policy on development and flood risk stating that:

*"When determining planning applications, local planning authorities should ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where, informed by a site-specific flood risk assessment following the Sequential Test, and if required the Exception Test, it can be demonstrated that:*

- *within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location; and*
- *development is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed, including any emergency planning; and it gives priority to the use of sustainable drainage systems".*

1.7 The Planning Practice Guidance (DCLG, 2014) requires that at the planning stage, the developer should prepare and submit an appropriate FRA to demonstrate how flood risk

from all sources of flooding to the development itself and flood risk to others will be managed now and when taking climate change into account.

1.8 To comply with the Planning Practice Guidance a FRA must be submitted for planning applications for developments within Flood Zones 2 and 3 (medium or high risk of fluvial or tidal flooding) and for all developments of 1 hectare or greater located in Flood Zone 1 (low risk).

1.9 A FRA should be appropriate to the scale, nature and location of the development and should identify and assess the risk from all sources of flooding to and from the development and demonstrate how any flood risks will be managed over the lifetime of the development.

1.10 An assessment of surface water and drainage is also required as part of the FRA in order to demonstrate how flood risk to others will be managed following development and taking climate change into account.

1.11 The Medway Council Core Strategy is currently in progress, consequently there are no policies currently available from this document.

1.12 Therefore the Medway Council Local Plan (Medway Council, 2003) was reviewed, however it was found no relevant policies exist in relation to this site.

1.13 The Strategic Flood Risk Assessment (SFRA) for Medway Council (Medway Council/Mott Macdonald, 2006) and Preliminary Flood Risk Assessment (PFRA) for Kent County Council (Kent County Council, 2011) provide a summary of flood risk issues across Medway Council's District and county.

1.14 Relevant information from the SFRA and PFRA is referred to throughout this report.

**Objectives**

1.15 The following specific objectives were set by Create Consulting Engineers Ltd after a review of the available data:

- To assess the suitability of the scheme with in relation to all sources of flooding;
- To assess the flood risk posed by the scheme once it is complete and operational;
- To suggest mitigation measures in order to reduce any residual risks to acceptable levels.

**Constraints and Limitations**

1.16 The copyright of this report is vested in Create Consulting Engineers Ltd and the Client. The Client, or his appointed representatives, may copy the report for purposes in connection

with the development described herein. It shall not be copied by any other party or used for any other purposes without the written consent of Create Consulting Engineers Ltd or the Client.

1.17 Create Consulting Engineers Ltd accepts no responsibility whatsoever to other parties to whom this report, or any part thereof, is made known. Any such other parties rely upon the report at their own risk.

1.18 The flood risk assessment addresses the flood risk posed to and from the proposed development, as shown on Drawing EDP 1995/77c.

1.19 This report has been undertaken with the assumption that the site will be developed in accordance with the above proposals without significant change. The conclusions resulting from this study are not necessarily indicative of future conditions or operating practices at or adjacent to the site.

1.20 Create Consulting Engineers Ltd has endeavoured to assess all information provided to them during this appraisal. The report summarises information from a number of external sources and cannot offer any guarantees or warranties for the completeness or accuracy or information relied upon. Information from third parties has not been verified by Create Consulting Engineers Ltd unless otherwise stated in this report.

## 2.0 SOURCES OF INFORMATION

2.1 The Information contained in this report is based on a review of existing information and consultation with interested parties.

**Records Review**

2.2 Key reports and websites reviewed as part of this study are listed in Table 2.1 below.

| Document/Website | Publisher | Date |
|---|---|---|
| Environment Agency (EA) Website – Fluvial/tidal flood maps, surface water flood maps, reservoir flood maps, Groundwater mapping | Environment Agency | Accessed April 2014 |
| Medway Council Strategic Flood Risk Assessment | Mott MacDonald/Medway Council | 2006 |
| Kent County Council Preliminary Flood Risk Assessment | Kent County Council | 2011 |
| Site Survey (Drawing Ref:1064 – SURV-001) | Target Surveys | 2014 |
| Southern Water waste and water supply asset plans (Appendix A) | Southern Water | 2014 |
| Southern Water Level 2 Capacity Check (foul water) (Appendix B) | Southern Water | 2014 |
| Site Investigation and Desk Study Report (Appendix C) | Ground Technology Services Ltd | 2014 |
| Illustrative Masterplan (Drawing Ref: EDP 1995/77c) | The Environmental Dimension Partnership | 2014 |

**Table 2.1. Key Information Sources**

**Site Walkover**

2.3 A site walkover was undertaken by Create Consulting Engineers Ltd in January 2014. A visual examination of the site as well as an assessment of the hydrology of the site and its surroundings was carried out.

**Site Investigation**

2.4 Site investigation was carried out by Ground Technology Services Ltd between April and May 2014 under the instruction of Create Consulting Engineers Ltd.

2.5 The first phase of investigations involved the excavation of three infiltration test pits along with a further five trial pits to ascertain the stratigraphy of the shallow geology across the site. The infiltration rates yielded in three of the trial pits were generally very good. However infiltration at these depths was into the surface of the underlying chalk bedrock

which was found to be very unstable. This instability of the chalk, along with the thickness and impermeable nature of the drift deposits means the use of shallow infiltration systems is unlikely to be viable in this geology without significantly reducing the developable area of the site.

2.6 In order to explore the opportunity for using deep borehole soakaways into the chalk five cable percussive boreholes were drilled to a maximum depth of 20.0 mbgl with two permeability tests in each, one at varying shallow depths and another at 20.0 mbgl in all cases. The shallow infiltration rates yielded here were variable whilst the tests at 20.0 mbgl all yielded very good infiltration rates.

2.7 The factual report for the site investigation works is included in Appendix C.

**Consultation**

2.8 The agencies and individuals consulted as part of this FRA are listed in Table 2.2.

| Consultee | Form of Consultation | Topics Discussed and Actions Agreed |
|---|---|---|
| Jonathan Atkinson, Groundwater & Contaminated Land Officer, Environment Agency | Email request for initial Environment Agency comments. Email response received 12 May 2014. | The Response (included in Appendix D) states that a site specific risk assessment should be compiled in relation to the use of deep borehole soakaways. This should cover previous site uses, the site investigations carried out, depth and nature of chalk and design of proposed pollution prevention measures. |
| Priscilla Mumby, Flood Risk Management Officer, Medway Council | Email request for comments in relation to surface water drainage. Response received 20 May 2014 | The response (included in Appendix D) states the proposed drainage solution is "reasonable as long as there are no other constraints (such as Groundwater Source Protection Zones) which could preclude the use of deep borehole soakaways".<br><br>The use of SUDS measures that could be incorporated into landscaping to enhance the amenity/bio-diversity of the development was encouraged. |
| Southern Water Developer Services | Email enquiry for asset plans. Response received 12th February 2014. | Asset plans (Appendix A) received in order to inform foul and surface water drainage strategies. |
| Southern Water Developer Services | Written request for capacity check for foul water. Response dated 26th March 2014, | The response (Appendix B) provided the following in relation to the capacity of the foul sewer network:<br>• There is currently insufficient capacity within the local foul sewerage networks to |

| Consultee | Form of Consultation | Topics Discussed and Actions Agreed |
|---|---|---|
| | | accommodate flows from the proposed development<br>• Improvements to the Southern Water foul water system are required to accommodate this flow.<br>• Required improvements include upsizing 686m of foul sewer pipes<br>Southern Water also confirmed the existence of an alternative connection point with sufficient capacity approx 1.8km the north west of the site. |

**Table 2.2 List of Parties consulted as part of this Flood Risk Assessment**

## 3.0 SITE DESCRIPTION & HYDROLOGICAL SETTING

### Site Location

3.1 The site is located on the southern side of Maidstone and is approximately centred at Grid reference 576760E 152270N. A site location plan is shown on Drawing 630/00/001B whilst a detailed site survey is included on Drawings 1064-SURV-001 Sheets 1-4.

### Description of Site and Surroundings

3.2 The site covers an area of approximately 23.6 ha and is located to the north and east of North Dane Way whilst being bound by residential areas to the south and west. To the north the site is bound by Ham Lane and agricultural land is found to the east.

3.3 The site comprises agricultural land with a section of wooded land, 'Hall Wood', located in the western part of the site. Gibraltar Farm and its associated buildings are located outside the site boundary to the north west of the site.

3.4 The site falls from a high point of approximately 136.0 mAOD in the south east to a low point of approximately 105.0 mAOD in the north west. A dry valley starting at the north east corner of Hall Wood also follows this terrain falling to a low point of the site adjacent to the Gibraltar Farm buildings. There is also a general fall across the site from west to east with an approximate level of 122.0 mAOD at the central western boundary and 110.0 mAOD at the north eastern boundary.

3.5 The site has vehicular access with un-made tracks, although there is no hard surfacing present and the land is free-draining.

### Surface Water

3.6 The site does not have any formal drainage and is not bound or crossed by any rivers, ditches or below ground drainage. It is assumed at present rainfall infiltrates the surface or runs off overland during more extreme events. Surface water runoff from the site has been noted at Gibraltar Farm during more extreme events.

3.7 There do not appear to be any watercourses in the general vicinity of the site. The nearest main river to the site is the River Medway approximately 6.0 km to the north of the site.

### Flood Defence Protection

3.8 The EA flood maps (Figure 3.1) indicate there are no flood defences protecting the site.

**Ground Conditions**

3.9 The BGS GeoIndex (accessed online, 2014) shows the majority of the site is overlain by superficial Clay-with-Flints (clay, silt, sand and gravel) with the Seaford Chalk Formation as bedrock. Along the route of the dry valley however and around Gibraltar farm itself the chalk is shown to outcrop with no superficial deposits present.

3.10 Extensive site investigation works found topsoil depths ranged between 0.2 and 0.4 m. The material encountered was generally cohesive comprising dark brown locally silty, sandy slightly gravelly to gravelly clay.

3.11 The Clay-with-Flints formation was encountered below the topsoil in all trial pits and boreholes which indicates this deposit is more widespread than the BGS mapping suggests. The Clay-with-Flints was encountered to depths ranging between 1.0 mbgl and 3.0 mbgl, with the exception of trial pits 4 and 6 which were terminated within the deposit at 4.2 and 3.8 mbgl respectively.

3.12 Chalk bedrock was encountered below the Clay-with-Flints to the maximum depths of all trial pits and cable percussive boreholes (with the exception of trial pits 4 and 6 as above). The shallower chalk deposits were found to be structureless and composed of very weak to angular to subangular fine to coarse chalk gravel in a weathered chalk silt matrix.

3.13 The chalk beneath the shallow deposits noted above was found to be generally moderately weak to the full 20.0 m depth of all cable percussive boreholes.

3.14 A full summary of this intrusive investigation is included in Appendix C.

**Groundwater**

3.15 Intrusive investigations at the site found no perched/shallow groundwater present. Borehole infiltration testing (Appendix C) encountered no groundwater in all five boreholes to a depth of 20.0 mbgl in all cases.

3.16 A borehole log noted on the BGS GeoIndex (Accessed online, 2014) is shown close to Gibraltar Farm just outside the northern boundary of the site with a rest water level of 79.0 mbgl in May 1958.

3.17 The site lies within a Zone 3 (total catchment) Environment Agency defined Groundwater Source Protection Zone. Any percolating water reaching the groundwater in this area therefore has potential to be extracted from a series of potable water boreholes in Chatham to the north at some point in the future (however the travel time is likely to be in excess of 400 days).

3.18 The underlying chalk is defined by the EA as a principal aquifer and is important at a strategic scale.

**Artificial Waterbodies**

3.19 There are no artificial water features present on the site with none noted in its vicinity.

**Site Drainage**

3.20 As the site is currently of an agricultural nature with the land being ploughed, surface storage and infiltration of rainfall will occur for lower intensity events whereas rainfall from events of increasing intensity will freely drain as overland flow towards the north and east.

3.21 No land drainage was encountered during the trial pitting. It is assumed the majority of rainfall drains via surface infiltration though some ponding may occur following heavy rain.

**Private Sewers**

3.22 As the site is of an agricultural nature it is understood there are no private sewerage assets located within its boundaries.

**Public Sewers and Water Supply**

3.23 A 300 mm foul water sewer passes in a north westerly direction along North Dane Way draining the residential areas to the south west of the site. A number of spurs of varying sizes (mainly 150 mm – 225 mm) pass into the sewer beneath North Dane Way before the sewer turns and passes through residential gardens 300 m to the west of the site boundary. Further to this it then flows to the north beneath rear gardens.

3.24 The only surface water asset in the vicinity of the site is a sewer beneath North Dane Way that originates from close to the sites eastern boundary. The size of this is unknown (not published on records) until the sewer is 300 m from the site where it is marked as being 900 mm in size. The sewer subsequently passes away to the north west along North Dane Way whilst receiving some drainage from the residential area to the west of the site. This sewer lies at a higher elevation than the site.

3.25 The urban area to the west and south west of the site is served by a network of predominantly 100 mm water supply mains.

3.26 A private water main is also marked passing to the north of Gibraltar Farm. A spur of this pipe crosses Ham Lane and serves Gibraltar Farm itself along with the two cottages close to the west. Part of this private pipe network does therefore lie within the site boundary.

**Flood Zones and Flood Mapping**

3.27 According to the EA flood maps (Figure 3.1), the site is located wholly within Flood Zone 1 (low probability). The National Planning Practice Guidance states this land is assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any given year (<0.1%).

3.28 The nearest flood zone to the site is associated with an ordinary watercourse approximately 1.0 km to the north of the site.

3.29 EA mapping shows the site is not at risk of flooding from a failure of any artificial waterbodies.

3.30 The EA surface water flood maps (Figure 3.2) show the dry valley passing through the site is at a 'low' and 'medium' risk of surface water flooding. Further drainage routes shown to be at a low risk are also shown passing into this dry valley.

3.31 The parts of the site with a low risk of surface water flooding have a probability of flooding of between 1 in 1000 (0.1%) and 1 in 100 (1%) in any given year with depths not exceeding 300 mm. Areas at a medium risk however have a probability of flooding of between 1 in 100 (1%) and 1 in 30 (3.3%) in any given year with depths between 300 and 900 mm.

**Flood History**

3.32 The 2006 Medway SFRA and 2010 Addendum Report both hold no information with regards historic flooding. The Kent PFRA includes mapping relating to historic flooding, however the area of the site is not covered by this mapping.

## 4.0 SCHEME DESCRIPTION

**Proposed Scheme**

4.1 Proposals for the scheme involve the development of the site to provide up to 450 new dwellings, together with ancillary land uses.

4.2 These proposals are shown on the indicative masterplan (Drawing EDP 1995/77c) included with this report. The drainage proposals are summarised on Drawing 630/02/001 and are set out in more detail below.

**Proposed Foul Water Drainage Strategy**

4.3 Foul water flows from the site will drain via gravity to a new foul water pumping station in the north western corner of the development (as shown on Drawing 630/02/001). This will pump foul flows via a rising main to Southern Water Manhole TQ77635000 within North Dane Way.

4.4 It is not possible to connect to the foul sewer via gravity due to parts of the site lying lower than the invert of Manhole TQ77635000.

4.5 Southern Water have agreed that foul flows from the site are acceptable, although off site upgrade works are required to ensure the system does not flood. These include the upsizing of a number of lengths of sewer. Full details are included in Appendix B.

4.6 Should the Client not wish to carry out any upgrade works Southern Water have noted there is currently available capacity at Manhole TQ76646602 1.8 km to the north west of the site. Therefore to facilitate a connection to this point, a much longer length of adoptable rising main would be required.

**Proposed Surface Water Drainage Strategy**

<u>Overview of the drainage strategy</u>

4.1 This section provides a summary of the proposed method of management and disposal of surface water runoff from the site to ensure that the hydrological impact of the development is minimised and to meet both local and national policy requirements for the management of surface water. As part of the design process, sustainable drainage methods have been considered from the start of the project and included where practicable, as summarised in Table 4.1.

| SUDS Option | Suitability/Included in the Scheme? | Comments |
|---|---|---|
| Soakaways and porous paving (infiltration) | ✓ | **Shallow infiltration (superficial)** - The shallow trial pitting found the overlying clays on the site to be cohesive and therefore unsuitable for infiltration forms of drainage.<br><br>**Shallow infiltration (Chalk)-** shallow infiltration testing was carried in 3 trial pits excavated into the Chalk to BRE365 (see Appendix C); resulting in very good infiltration rates ($7.04 \times 10^{-4}$ m/s – $7.12 \times 10^{-5}$ m/s) being achieved at all locations. However it is noted that the structure of the shallow Chalk is very poor, and the use of shallow infiltration systems into this strata is would overly constrain the development as a 10.0 m exclusion zone to any building or adoptable road would be required to avoid the risk of solution features destabilising foundations, as noted in Appendix C.<br><br>**Deep infiltration (Chalk)** – Infiltration testing (constant head tests) has demonstrated that there is good infiltration at depth with the chalk, such that this method of drainage is the preferred method.<br><br>**Porous paving** - will be used to treat surface water flows from non adoptable road areas, driveways and parking areas. Should the geology be suitable where porous paving is used (i.e. the chalk is suitably shallow) this permeable paving could also be used for infiltration drainage provided it is draining its own surface area only. |
| Porous paving (storage/treatment) | ✓ | Will be used to treat surface water flows from non adoptable road areas, driveways and parking areas prior to discharge via the deep borehole soakaways. |
| Rainwater Harvesting | * | Not included in the client and architect design proposal at present. |
| Swales | ✓ | Swales will be used to convey and treat runoff from adoptable road areas. |
| Attenuation Ponds (above ground storage/detention basin) | ✓ | Attenuation basins will be included in the scheme with a total of eight of these features required across the site to provide sufficient attenuation to enable the disposal of all surface water safely into the ground via deep borehole soakaways.<br><br>In total these basins will require an area of |

| | | |
|---|---|---|
| | | approximately 0.70 ha. A slightly larger area is likely to be required at the detailed design stage in order to tie in to existing ground levels. |
| Below ground storage in cellular systems | * | Not included in the client and architect design proposal at present. |
| Flow control devices | X | Flow control devices are not required |
| Green Roofs/Brown Roofs/Blue Roofs | * | Not included in the client and architect design proposal at present. |

**Table 4.1: SUDS Options**

*Key:*

✓ *Suitable for use and included in the scheme*

* *Possibly suitable for use – not included in the client and architect design proposal at present – should be considered further as part of the detailed design*

*X* *Unlikely to be suitable for use*

4.2 Based on the current masterplan for the site, an outline surface water drainage strategy for the proposed scheme has been developed (Drawing 630/02/001), which can be summarised as follows:

- The impermeable areas of the site will drain via a separate piped drainage network.
- All surface water will then be attenuated in one of eight attenuation features proposed across the site ranging in size between 622 $m^2$ and 1104 $m^2$. At present it is envisaged that the attenuation features will be grassed basins incorporated into soft landscaped areas within the open space and circulation areas. A 10m buffer from all roads and buildings will be required.
- A full summary of the drainage areas and their associated attenuation basins is included in Table 4.2. Based on the initial borehole testing, and the assumption that 60% of the developed areas of the masterplan will be hardstanding, 26 boreholes will be required. This equates to roughly two infiltration boreholes being required per developed hectare.

| Drainage Area[1] | Total Area (ha) | Area with 60% Impermeability Factor Applied (ha)[1] | Surface Area of Attenuation Basin at Bank Tops ($m^2$) | Maximum Volume of Water Stored[3] ($m^3$) | Number of Borehole Soakaways |
|---|---|---|---|---|---|
| 1 | 1.93 | 1.16 | 1069 | 709 | 2 |
| 2 | 1.13 | 0.68 | 644 | 360 | 2 |
| 3 | 1.12 | 0.67 | 622 | 352 | 2 |
| 4 | 1.82 | 1.09 | 863 | 544 | 4 |
| 5 | 1.72 | 1.03 | 802 | 506 | 4 |
| 6 | 2.00 | 1.20 | 933 | 613 | 4 |
| 7 | 2.34 | 1.40 | 1104 | 749 | 4 |
| 8 | 1.95 | 1.17 | 962 | 592 | 4 |

**Table 4.2. Summary of drainage areas and attenuation features.**

*Key:*
*[1]Drainage areas summarised on Drawing 630/02/001*
*[2]Assumes 60% of 'developed area' shown on the masterplan drawings will be impermeable*
*[3]During the 1 in 100 year plus 30% climate change event*

4.3 The following sections set out in more detail the drainage strategy for surface water.

Initial Design Parameters

4.4 Calculations demonstrating that the soakaways and associated attenuation can be accommodated in the scheme are included in Appendix F and shown in plan form on Drawing 630/02/001.

4.5 Given the nature of the infiltration testing, these calculations assume a constant infiltration rate over all hydraulic head values. However at the detailed design/borehole construction stage the head flow relationship will be calculated for each specific borehole, allowing the attenuation requirements to be accurately determined. The method used at present is considered to be a very conservative approach at this stage.

4.6 The infiltration rate used for the calculations in Appendix F uses the lowest achieved infiltration rate at 20.0 mbgl (5.56 l/s from test Borehole 2) with a factor of safety of two applied, therefore giving a value of 2.78 l/s.

- As noted in Appendix C lower infiltration rates were yielded at shallower depths, however it was found the testing at 20.0 mbgl yielded consistent rates. Therefore all boreholes will be drilled to an appropriate depth to achieve a suitable infiltration rate, with an assumption that the rates will be consistent at 20.0 mbgl in all cases.

- It should also be noted that the 20.0 mbgl test in Borehole 1 yielded a lower infiltration rate. This was due to the capacity of the pump used not allowing a

sufficient amount of water to enter the borehole. Two higher powered pumps were used from this point onwards to achieve the results used for design.

- Some borehole testing results in Appendix C noted the tests as 'incomplete'. This was a result of a constant head not being achieved due to the two pumps not being able to pass water into the borehole at a high enough rate to bring the hydraulic head to a steady level. Therefore the infiltration rates used for design are deemed conservative in this respect, because, should more/larger pumps have been used the infiltration rates would have been higher upon achieving a constant head level.

Design Principles

4.7 Assuming the highways are adopted, it will be necessary to agree suitable wayleaves, easements etc. All adoptable highways will require separate drainage systems and dedicated borehole soakaways. Therefore upon the production of a more detailed masterplan at the detailed design stage these drainage systems can be split from the private roof areas and non-adoptable roadways.

4.8 All attenuations systems included within the drainage strategy are designed to the 1 in 100 year standard with a 30% inclusion for climate change as per best practice. The attenuation basins have been designed to have a maximum of 1.0 m water present during the 1 in 100 year plus climate change event with a 300 mm freeboard, therefore giving a 1.3 m total basin depth with 1 in 4 side slopes. These will most likely be deeper in certain areas in order to allow for tying in to existing gradients, however it is proposed to maintain 1 in 4 side slopes in all instances as per best practice standards for safety purposes.

4.9 All deep borehole soakaways will be constructed such that their invert levels are set as shallow as possible, whilst it will be ensured the infiltration rate at this depth is also suitable and meets the design requirements. The on site testing already undertaken found good infiltration at 20.0 mbgl in all test boreholes whilst it was much more variable at shallower depths (4.5-10.0 mbgl). Therefore the invert levels of the borehole will be set on a 'location specific' basis at the detailed design stage.

4.10 All borehole soakaways are required to be at least 5.0 m above the seasonal high groundwater level to allow a suitable unsaturated zone in accordance with EA requirements. In this instance the unsaturated zone will be significantly greater than 5.0 m given the anticipated groundwater level noted in Section 3 (approximately 79.0 mbgl).

4.11 A 10.0 m radius is normally required between the centre of any borehole and any buildings and adoptable highways. In the case of this site a 10.0 m radius has been maintained to all roads and development areas as shown on Drawing 630/02/001. Also a 10.0 m distance has been maintained between all borehole centres.

4.12 Given the placement of boreholes within attenuation basins a standard construction detail will be adopted whereby the boreholes will be constructed in a normal fashion with a siphon head on top of the borehole in the base of a manhole chamber. Instead of an incoming pipe however it is proposed to grate the top of the manhole so water flowing into the basins can subsequently flow into the borehole chambers.

4.13 A suitable access will be made into the attenuation basins at the detailed design stage to facilitate access for vehicles to carry out maintenance (i.e. debris removal/borehole flushing). This will be achieved by an access ramp being made on one side of each basin whereby the bank will be graded at approximately 1 in 10 (as oppose to the standard 1 in 4 bank grade) whilst ensuring the attenuation volume is not reduced.

4.14 Given that surface water passing into the basins will generally take one flow path to the borehole chambers in less critical events (i.e. normal rainfall events when little or no attenuation volume is required) there is potential for scour across the basin surface. Therefore it is proposed to include a geo-membrane and cobbled surface for the water to flow across to avoid scour and also reduce the amount of sediment washed into borehole chambers by allowing settlement prior to outfall to the chambers.

4.15 Where attenuation basins will be dug into the shallow chalk an appropriate liner will be incorporated to avoid direct infiltration into the chalk in order to alleviate the risk of solution features forming.

4.16 Finally it should be noted that location specific infiltration testing at the detailed design stage with larger capacity pumps will likely yield higher infiltration rates. Also the installed borehole soakaways will be of a larger diameter, further increasing the infiltration potential. With this in mind it is likely that fewer boreholes will be required given the anticipated improvements to the head flow relationships.

Pollution Prevention Measures

4.17 Pollution Prevention measures will be incorporated in line with the SUDS Manual and the requirements of the Environment Agency GP3 Guidance. The proposed measures are summarised as follows:

- Tanked permeable paving will be used for all non-adoptable road ways, parking areas and driveways. This will include a 500 mm sub-base (as oppose the standard 450 mm) in order to provide two levels of treatment;

- Grassed swales, filter trenches and filter strips will be used where possible to provide treatment and transmission of surface water flows from adoptable road areas.

- All borehole chambers will be fitted with a raised siphon head or inverted 'u' bend to ensure any oils reaching the chamber remain on the water surface and do not pass into the borehole. This will also allow any sediment within the water to settle on the base of the chamber and not pass into the borehole.

- Should they be required (i.e. for large car parking areas etc) oil interceptors will be used where necessary and where adoption issues do not allow the above forms of SUDS to be implemented.

4.18 Roof areas will drain direct to the boreholes and associated attenuation basins as no formal treatment is required for these areas.

Maintenance

4.19 An appropriate maintenance regime for the borehole soakaways and associated attenuation features will be developed at the detailed design stage by the site management company following further consultation and agreement with the Environment Agency, Local Highways Department and SUDS Approval Body (Medway Council) if in place at this time. This is likely to involve regular mowing and rubbish/debris removal from attenuation basins as well as regular silt removal from borehole chambers.

Groundwater Risk Assessment

4.20 Baseline geological and hydrogeological conditions can be found in Section 3 and in the desk study report (Ground Technology Services, 2014) included as Appendix C of this report.

4.21 Based on this information the following conceptual site model (Table 4.3) has been developed to assess the risk to groundwater from site drainage.

| Source | Receptor | Pathway | Risk rating | Justification/additional mitigation requirements and other recommended actions | Residual risk following mitigation |
|---|---|---|---|---|---|
| Oil/Fuel leakages from vehicles accessing/parking on the site.<br><br>As noted in GP3 (EA, 2013) the risk of fuel and oil leaks are negligible under normal conditions. | Groundwater beneath the site – Chalk Aquifer (Principal Aquifer) | Via surface water drainage and infiltration | Low | • Pollution Prevention measures will be incorporated in line with the SUDS Manual and the requirements of the EA GP3 Guidance (EA, 2013). The proposed measures are summarised as follows:<br>o Tanked Permeable paving will be used for all non-adoptable road ways, parking areas and driveways. This will include a 500 mm sub-base (as oppose the standard 450 mm) in order to provide two levels of treatment;<br>o Grassed swales, filter trenches and filter strips will be used where possible to provide treatment and transmission of surface water flows from adoptable road areas.<br>o All borehole chambers will be fitted with a raised siphon head or inverted 'u' bend to ensure any oils reaching the chamber remain on the water surface and do not pass into the borehole. This will also allow any sediment within the water to settle on the base of the chamber and not pass into the borehole.<br>o Should they be required (i.e. for large car parking areas etc) oil interceptors will be used where necessary and where adoption issues do not allow the above forms of SUDS to be implemented.<br>o Roof areas will drain direct to the boreholes and associated attenuation basins as no formal treatment is required for these areas.<br>• Notices will be in place in homeowner packs and on signage in communal car parks and attenuation basins to inform residents that the site drainage discharges to ground.<br>• Regular inspection and maintenance of the site drainage network will be undertaken as set out in a management plan to be prepared and the detailed design stage and implemented for the lifetime of the development. . | Low risk |
| | Site is located within a Groundwater SPZ 3 – a Public water supply borehole is located approximately 2.5km north of the site | Via surface water drainage, infiltration and lateral and vertical migration | Low | | |
| Significant incident – major leak due to fuel/oil loss accident, vandalism or fly-tipping | Groundwater beneath the site – Chalk Aquifer (Principal Aquifer) | Via surface water drainage and infiltration | Medium | | |
| | Site is located within a Groundwater SPZ 3 – a Public water supply borehole is located approximately 2.5km north of the site | Via surface water drainage, infiltration and lateral and vertical migration | Low | | |
| Foul sewerage network | Groundwater beneath the site – Chalk Aquifer (Principal Aquifer) | Cross contamination in the event of a surcharging manhole entering the surface water drainage network, | Low-medium | • The drainage networks will be separate. There will be management plan for the site drainage prepared at the detailed design stage to ensure, regular inspection and maintenance of the site drainage.<br>• The foul water drainage network should be appropriately sealed to avoid any cross contamination with the surface water network.<br>• Information will be provided to homeowners to avoid the misconnection of any future connections to the site drainage network. | Low risk |
| | Site is located within a Groundwater SPZ 3 – a Public water supply borehole is located approximately 2.5km north of the site | | | | |

**Table 4.3. Conceptual Site Model.**

4.22 Based on the above conceptual model the following summarises the receptors and proposed mitigation measures:

- The groundwater is deep (approximately 79.0 mbgl);
- No direct groundwater discharges will be made (a clearance of approximately 59.0 m above the groundwater table is expected below the base of the nearby recorded groundwater level);
- Adequate pollution control measures will be incorporated into the surface water drainage network to manage the usual sources of contamination which are likely to be isolated in occurrence or pose low level risks;
- The nearest recorded public potable groundwater abstraction is approximately 2.5 km north of the site;
- Regular inspection and maintenance of all surface and foul water drainage assets will be undertaken by site management and/or any appropriate body including any future adopting authority as set out in a management plan to be agreed as part of the detailed design;
- The proposed development is residential and no large areas of parking are expected;
- Information will be provided to homeowners as to the fate of surface water;
- No sensitive ecological receptors are noted in the general vicinity of the site;
- The detailed design of the site drainage will ensure that the separate foul and surface water sewer networks will be provided and will consider the routing of surcharging foul sewers in the event of a blockage or a failure.

4.23 These measures have been incorporated into the drainage design and will be further developed as part of the detailed design.

4.24 Due to the relatively rural nature of the surrounding area a full water features survey should be undertaken as part of the detailed design to confirm there are no private water supply wells. This will inform the need for further risk assessments or mitigation measures. This may require careful siting of the borehole soakaways away from the abstraction wells, incorporation of basic treatment measures or the provision of a replacement mains connection.

## 5.0 FLOOD RISK ASSESSMENT

### Scope of Work

5.1 The scope for the FRA was defined to meet the brief outlined in Section 1.15 of this report, and includes the following:

- Identification and assessment of all sources of flooding to the scheme.
- Assessment of the hydrological impact of the proposed scheme
- Mitigation measures to reduce any risks to acceptable levels
- Identification of any residual risks
- Statement confirming how climate change has been considered.

5.2 This report has been prepared to be consistent with the requirements of the NPPF (DCLG, 2012) and associated Planning Practice Guidance (DCLG, 2014).

### Flood Risk to the Scheme

5.3 Based on a review of the available information pertaining to the site the potential sources of flooding have been identified in Table 5.1.

| Potential Source | Pathway | Potential Linkage to Site | Justification |
|---|---|---|---|
| Surface water features | Inundation of floodplains/ overtopping of lake banks | No | The site is located in Flood Zone 1 and is assessed as having a less than 1 in 1000 (<0.1%) probability of flooding in any one year. |
| Groundwater | Perched/shallow groundwater | No | Site investigation encountered no perched or shallow groundwater to the maximum depth of all boreholes (20.0 mbgl). |
| Private foul and surface water sewer network – sewer flooding from site drainage | Exceedance of sewer capacity due to surcharge/blockages of pipe work/pumped foul drainage | Yes | Blockage or surcharge/failure of any existing private surface or foul water sewers serving the site. Sewer flooding of this nature is a residual risk managed by the design and maintenance of the private sewer network. |
| Public foul and surface water sewer network (Southern Water assets) and private off-site | Exceedance of sewer capacity due to surcharge/blockages of pipe work | Yes | Blockage or surcharge of the nearby Southern Water network serving the nearby residential development including private sewers. This could cause localised flooding of the site. Again this is a |

| Potential Source | Pathway | Potential Linkage to Site | Justification |
|---|---|---|---|
| drainage – Sewer Flooding | | | residual risk managed by the design of the proposed ground levels along with maintenance of the public sewer network. |
| Private and public water supply assets (Off site private supply pipes and South East Water assets) | Ruptured infrastructure and/or leakage | Yes | Ruptured water supply networks (both publicly and privately owned) act as a residual risk managed by the design and maintenance of both off and on site assets. |
| Surface water – Overland flow from extreme rainfall | Runoff due to exceedance of drainage network capacity and from undrained areas within the scheme and off-site. | Yes | The EA surface water flood map notes an area of low (0.1 % - 1 %) and medium (1 % - 3.3 %) surface water flood risk following the dry valley through part of the site along with some other small areas.<br><br>This is a residual risk managed by best practice design and appropriate flood routing methods. |

**Table 5.1: Flood Risk to the Scheme**

**Flood Risk from the Development**

5.4 As the site is currently greenfield, the proposed development will significantly increase the area of hard surfacing meaning the runoff characteristics will be altered. Therefore an assessment of the proposed surface water drainage scheme is required to ensure the scheme does not increase flood risk to the surrounding area.

5.5 The following sections provide a drainage assessment of the scheme and appropriate mitigation measures are presented in Table 5.3.

Changes to Surface Water Runoff Rates

5.6 Calculations included in Appendix G estimate the current greenfield runoff rates from the site as shown in Table 5.2. These calculations consider the whole site area of 23.93 ha and a Winter Rainfall Acceptable Potential of 4 based on site observations as opposed to the values shown on the Wallingford Mapping.

| Rainfall Event | Greenfield runoff rate |
|---|---|
| Q 1 year | 90.6 l/s |
| Q 30 year | 238.9 l/s |
| Q 100 year | 340.1 l/s |

**Table 5.2: Greenfield Runoff Rates from the Site for Various Rainfall Events.**

5.7 As the site is free draining, it is assumed that under current conditions, any surface water will currently infiltrate or runoff overland during extreme rainfall events. The drainage strategy (Section 4) ensures that sufficient sustainable drainage systems have been included to retain and infiltrate all surface water runoff to ensure no surface water will runoff from the site for all rainfall events up to the 1 in 100 year storm (including an allowance for climate change). Calculations in Appendix F confirm this.

5.8 For all events beyond the 1 in 100 year rainfall event, the situation will be no worse than existing. Opportunities to reduce runoff from the site in events beyond the design rainfall event are set out in Table 5.3.

Effects on Flows in Local Watercourses

5.9 As the surface water generated by the hardstanding areas will drain via infiltration forms of SUDS, there will be no impact on flows in the public or privately owned sewers or flows in nearby watercourses.

Changes in Foul Water Flows

5.10 The development will increase foul flows to the nearby Southern Water network. However consultation has established that a flow for up to 500 homes can be accommodated in the network, downstream of the proposed point of connection once upgrades have been made as part of the connection process. As long as sufficient upgrades are made the development will not significantly increase the risk of flooding in the foul sewer network

**Mitigation**

5.11 Flood risk mitigation measures are proposed in Table 5.3 in order to manage residual flood risks and to ensure that the development poses no increased flood risk to the surrounding area.

| Type of Flooding (Source) | Issue | Mitigation Measures | Justification | Residual Risk[b] |
|---|---|---|---|---|
| Flooding from site drainage | Blockages or surcharges in the site drainage and sewers may result in flooding of the development and surrounding area. | • All drainage systems will be designed to current best practice standards with an inclusion for Climate Change as per Section 4.<br>• The external areas of the development should be designed to ensure that any potential flood waters will be directed away from dwelling entrances and all access points.<br>• Routine inspection and maintenance of foul and surface water drainage systems by site maintenance or statutory authorities.<br>• Borehole soakaways will be tested during their installation to ensure the flow rates noted in Section 4 can be achieved and a sufficient additional capacity should be allowed for in accordance with best practice guidance.<br>• Floor levels of dwellings will be raised above the surrounding area (as per Building Regulations standards).<br>• At the detailed design stage consideration will be given to flood flow routes in the event of a system surcharge/blockage, these will ensure any surcharged water is kept within kerb lines and away from properties. | In the event of foul and surface water flooding occurring the effect of flooding to external areas and dwellings will be minimised | Low |
| | The foul sewerage network will require pumping, which may fail. | • The pumping station should incorporate duty standby pumps so a back-up pump is always available in the event of failure.<br>• The pumping station will also incorporate emergency storage in line with Sewers for Adoption 7th Edition to avoid flooding in the event of a system failure (this will allow time for foul water to be removed from the pumping station by tanker or repairs to be made).<br>• Routine inspection and maintenance the foul drainage systems by the site maintenance company or adopting authority. | This will ensure the risk of failure is mitigated as far as reasonably practical | Low |
| Risk of Flooding from public or private (off-site) foul and surface water network – Sewer Flooding | Blockages or surcharges in the off-site sewer network may result in localised flooding of the development and surrounding area or backing up in the on-site sewer network | • Design of the connection to the public sewer should be informed by surveys as part of detailed design of the drainage and agreed with Southern Water.<br>• Regular inspection and maintenance of the off-site public sewer network by Southern Water and private network by appropriate persons. | In the event of foul and surface water flooding occurring the effect of flooding to external areas and dwellings will be minimised | Low |
| Flooding from public and private water supply systems | Ruptured water supply pipes supplying the scheme have the potential to flood the development and surrounding area | • Design and construction of water supply systems to current best practice standards.<br>• Routine inspection and maintenance of assets by South East Water and property owners.<br>• Floor levels of dwellings will be raised above the surrounding area (as per Building Regulations standards).<br>• Maintain an appropriate easement or divert as necessary the private water supply main within the northern site boundary. | This will ensure the risk of failure is mitigated as far as reasonably practical | Low |
| Flooding from surface water runoff – overland flow | Risk of flooding from rainfall events in exceedance of the drainage design from off site and on site drainage including undrained areas during the extreme rainfall event | • The detailed design of the development will make an allowance for surface water ponding from rainfall events in exceedance of the drainage design capacity (i.e. the 100 year plus 30% climate change). This will ensure any ponding water is contained within the kerb lines and on site.<br>• External areas will also be profiled as part of the detailed design to ensure that surface water runoff will be directed away from dwellings and into the roads in accordance with best practice guidance.<br>• Consider the need and opportunities for land drainage to undrained areas and to address exceedance flows as part of the detailed design.<br>• Floor levels of dwellings will be raised above the surrounding area (as per Building Regulations standards). | In the event of this extreme rainfall event dwellings will not be inundated whilst flooding of the surrounding area is also prohibited. | Low |
| Increased flood risk to properties as a result of the scheme | The scheme has potential to increase surface water runoff rates volumes to the surrounding area (as a result of hard surfacing impeding rainfall infiltration to the ground) | • Inclusion of SUDS in the detailed design of the drainage to ensure attenuation is provided to ensure the site does not flood during the 100 year plus 30% climate change event (as per Section 4).<br>• Ensure all sustainable drainage systems are maintained and routinely inspected throughout the development by site management company or adopting authority.<br>• Consideration of flood routing at the detailed design stage will ensure any rainfall in excess of the extreme event will be retained on site within the kerb lines, therefore posing low risk to dwellings.<br>• Agree drainage strategy with the EA and Southern Water as part of the detailed design stage.<br>• Ensure borehole infiltration rates are maintained once boreholes are installed. | The will ensure the existing drainage pattern is impeded as little as possible – therefore not increasing flood risk to the site or surrounding area | Low |
| | The development of the scheme will increase foul water flows in the local Southern Water network | • Southern Water has provisionally agreed to connection points and allowable flow rates subject to network upgrades. Any changes should be discussed and agreed with Southern Water. A Section 106 application to Southern Water should be made as part of the detailed design of the drainage.<br>• Network upgrades, as per Appendix B should be carried out before any connection is made to ensure capacity is available in the network.<br>• Routine inspection and maintenance of assets by Southern Water and site management company. | These measures will ensure the development does not increase any pre-existing risk of overloading of the public foul sewer network. | Low |

**Table 5.3: Proposed Mitigation Measures and Residual Risk Assessment**

*Key:*

[a] *Following mitigation measures*

**Residual Risks**

5.12 Assuming the mitigation measures are adopted (refer to Table 5.3), the principal residual risks relate to surcharges, blockages and/or pump failure in private or public sewer networks, onsite burst water mains, and surface water flooding from extreme rainfall.

5.13 As long as the water supply infrastructure, public sewers and site drainage are routinely inspected and maintained by property owners, site management, Southern Water, South East Water or any other adopting authorities then the residual risk to the site downstream properties will be minimised.

**Climate Change**

5.14 Climate change has important implications for the assessment and management of flood risk. The NPPF (DCLG, 2012) requires that climate change is considered when making an assessment of flood risk posed to future development.

5.15 Climate change has the potential to affect all identified sources of flooding at the site. The likely impacts of climate change include increased severity of rainfall events as well as wetter winters leading to higher groundwater levels.

5.16 The influence of climate change on rainfall intensity has been taken into account by the surface water drainage strategy as an inclusion of 30% has been made for climate change for all rainfall events up to and including the 1 in 100 year event in accordance with NPPF requirements (DCLG, 2012).

## 6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 This Flood Risk Assessment has shown that the scheme can be constructed and operated safely and without significantly increasing the risk of flooding to the site and surrounding area, providing the mitigation measures outlined in Table 5.3 are implemented.

6.2 Assuming the mitigation measures are adopted, the principal residual risks relate to surcharges, blockages and/or pump failure in private or public sewer networks, onsite burst water mains, and surface water flooding from extreme rainfall in excess of the design of the site drainage.

6.3 As long as the water supply infrastructure, public sewers and site drainage are routinely inspected and maintained, then the residual risk to downstream properties will be minimised. The residual risks outlined here will be reviewed as part of the detailed drainage design to ensure they are minimised.

6.4 The detailed drainage design should include sufficient testing and groundwater monitoring to inform and refine the detailed drainage design.

## 7.0 REFERENCES


i. Balmforth, D., et al. (2006) *Designing for exceedance in urban drainage – good practice, Report C635.* London: CIRIA.

ii. Department for Communities and Local Government/Government Office for the South East (2009) *The South East Plan, Regional Spatial Strategy for the South East of England.*

iii. Department for Communities and Local Government. (2012) *National Planning Policy Framework*. Crown Copyright, London.

iv. Department for Communities and Local Government. (2014) *Planning Practice Guidance*. Crown Copyright, London. (accessed online)

v. Environment Agency (2013) *Groundwater Protection: Principles and Practice (GP3). Version 1.1.* Environment Agency, Bristol.

vi. Environment Agency Flood Maps – Available at: http://maps.environment-agency.gov.uk/wiyby/wiybyController (accessed June 2014)

vii. Kent County Council (2011) *Preliminary Flood Risk Assessment - Final*. Kent County Council.

viii. Medway Council (2003) *Medway Local Plan*. Medway Council.

ix. Medway Council/Mott MacDonald (2006) *Medway Strategic Flood Risk Assessment Main Report*. Mott MacDonald, Cambridge.

x. Office of the Deputy Prime Minister. *The Building Regulations 2000. Drainage and Waste Disposal Approved Document H, 2002 Edition*.

xi. Reed, D. Faulkner, D. Robson, A. Houghton-Carr, H. Bayliss, A. (2008) *Flood Estimation Handbook*. Centre for Ecology and Hydrology. Natural Environmental Research Council.

xii. Water UK/WRc plc (2012) *Sewers for Adoption 7th Edition'* WRc plc Swindon.

xiii. Woods-Ballard., et al. (2007) *The SUDS Manual.* Report C697. London: CIRIA.

# FIGURES

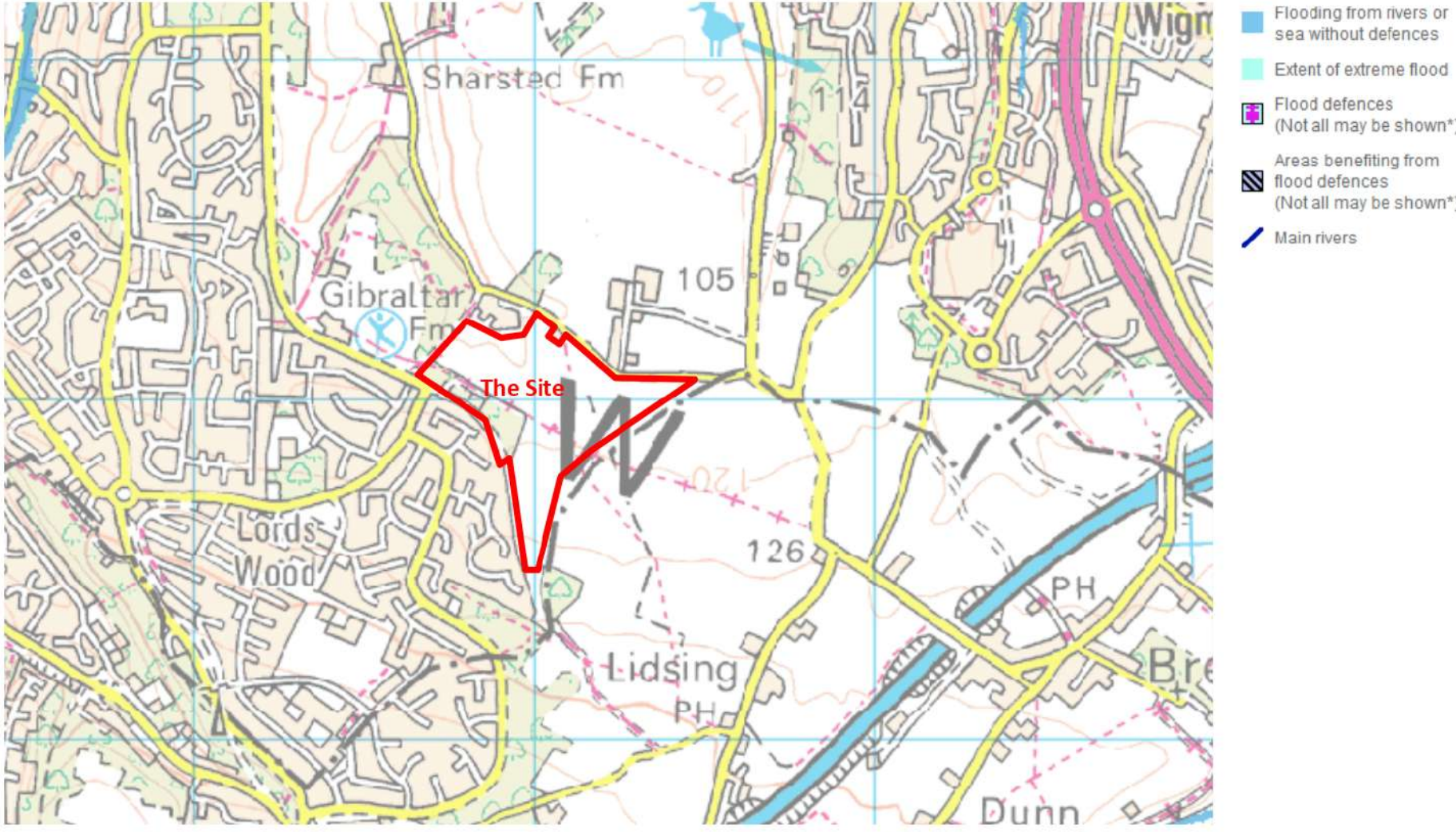


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**Figure 3.1 Environment Agency Flood Map (Source: Environment Agency Website, accessed June 2014)**

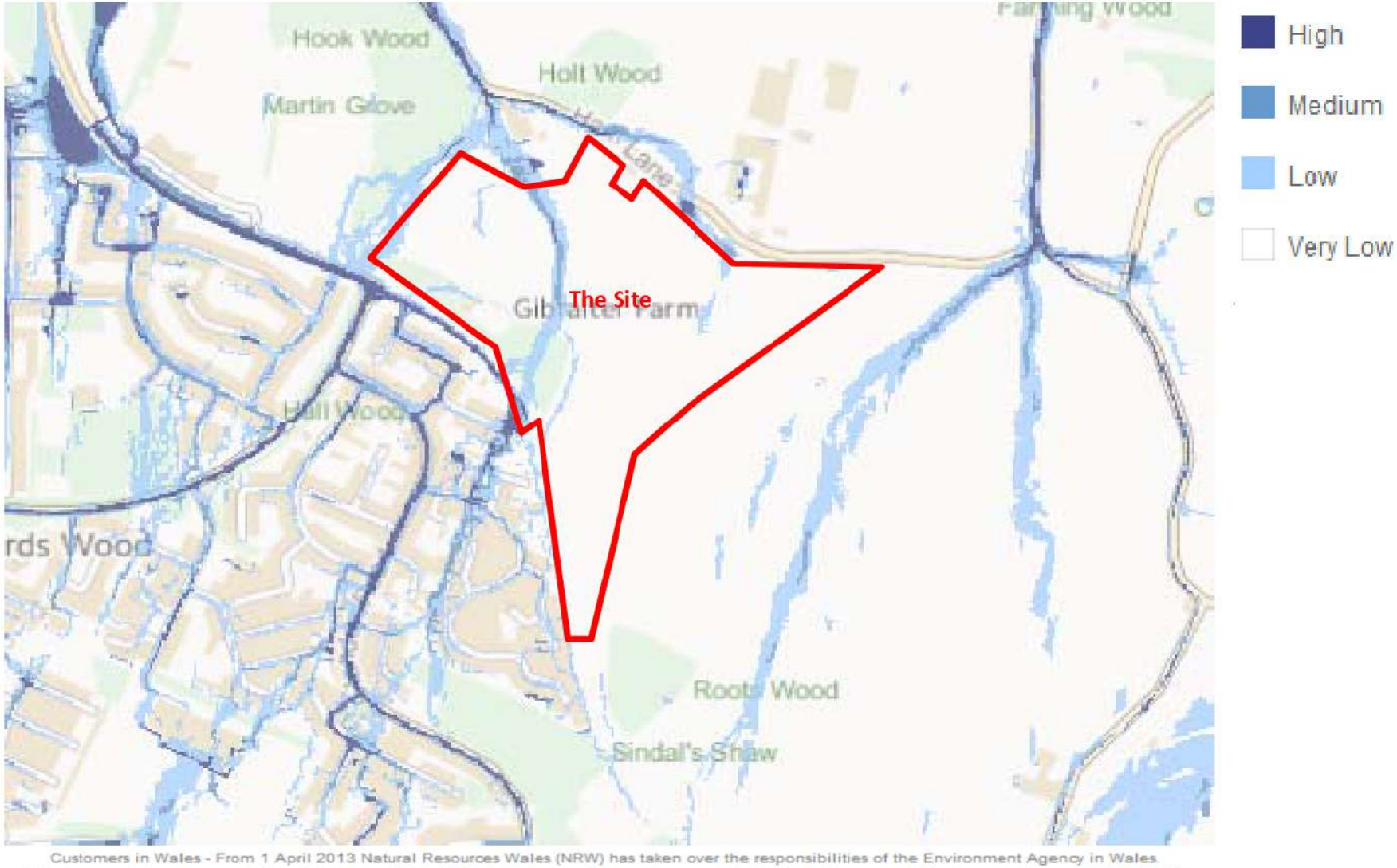


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**Figure 3.2 Environment Agency Surface Water Flood Map (Source: Environment Agency Website, accessed June 2014)**

# APPENDICES

# APPENDIX A

Original with Accounts (VAT receipt) ES

Southern Water

RECEIVED - 5 FEB 2014

Create Consulting Engineers Ltd
15 Princes Street
Norwich
NR3 1AF

| | |
|---|---|
| Your Ref | GS/CS/P14-630 |
| Our Ref | 167518 |
| Date | 03 February 2014 |
| Contact | searches@southernwater.co.uk<br>Fax 01634 844514<br>DX:400450 Chatham 5 |

Attention: Graham Sinclair

Dear Sirs

**Provision of Sewer & Water Main Record Extracts – VAT Receipt**

**Gibraltar Farm, Medway, Kent**
Further to your recent enquiry regarding the provision of Southern Water apparatus record extracts for the above location.

Please be aware that there are areas within our region in which there are neither sewers nor water mains. Similarly, whilst the enclosed extract may indicate the approximate location of our apparatus in the area of interest, it should not be relied upon as showing that further infrastructure does not exist and may subsequently be found following site investigation. Therefore actual positions of the disclosed (and any undisclosed) infrastructure should be determined on site, because Southern Water does not accept any responsibility for inaccuracy or omission regarding the enclosed plan and accordingly it should not be considered to be a definitive document.

I confirm payment of the appropriate fee in the sum of £58.00

The breakdown of costs is as follows: -

- Provision of record extracts £48.33
- VAT @ 20.0% £9.67

**VAT Registration Number 543 9000 63**

Should you require any additional information regarding this matter please contact this office at the address given at the foot of this letter.

Yours faithfully

Land Search Department

Letter B

# SOUTHERN WATER SERVICES LIMITED

164058

162892

5775537

5793483

## LEGEND - MAINS

- Distribution Main / Communication pipe
- Trunk Main
- RAW — Raw water main
- NP — Non potable
- Abandoned main
- P — Proposed Main
- FM — Fire main
- Non SWS
- Sluice valve
- Closed valve
- AV — Air valve
- Butterfly valve
- Pressure reducing valve
- Reflux valve
- MV — Motorised valve
- Clockwise closing valve
- Fire Hydrant
- WO — Washout
- WOH — Washout hydrant
- M — Meter
- Capped end
- EP — Emptying plug
- Stopcock
- LNC — Leak Noise Correlator Survey Point
- AN — Anode
- TC — Telemetry cable
- AP — Access point / hatchbox
- D — Dialysis machine
- BPT — Break pressure tank
- Change node
- Pumping station
- Booster station
- Insertion Flow Meter Point
- Water tower
- Service reservoir
- Water Supply Works
- Bore hole / Well
- Intake
- Customer site
- Swab insertion point

## MATERIALS

| | |
|---|---|
| Alkathene | AK |
| Cast iron | CI |
| Spun (grey) iron | SI |
| Concrete | CO |
| Ductile iron | DI |
| Bonded Asbestos Cement | BAC |
| Glass reinforced plastic | GRP |
| Glass reinforced epoxy | GRE |
| (Unplasticised) Polyvinyl chloride | PVC |
| Polyethylene | PE |
| Steel | ST |
| Concrete segments bolted | CSB |
| Concrete segments unbolted | CSU |
| Galvanised iron | GI |
| Ductile sleeve | DS |
| Concrete pre-stressed | CPS |
| High performance polyethilene | HPE |
| Unknown | ?? |

| | | | |
|---|---|---|---|
| O.S. Ref. TQ7863SE | Drawn by: | spaceyk | The positions of pipes shown on this plan are believed to be correct, but Southern Water Services Ltd accept no responsibility in the event of inaccuracy. The actual position of pipes must be determined on site. |
| | Scale: | 1:2500 | WARNING: BAC pipes are constructed of Bonded Asbestos Cement<br>WARNING: Unknown (UNK) materials may include Bonded Asbestos Cement |
| Title: 167518_Gibraltar Farm_4 | Date: | 04/02/2014 | Based upon Ordnance Survey Digital Data with the permission of the Controller of H.M.S.O. Crown Copyright Reserved Licence No. WU298530 |

N

Southern Water

# SOUTHERN WATER SERVICES LIMITED

162665

Cowbeck Wood
Reed's Croft Wood
Hoole's Grove
Lords Wood
Hoole Wood
Cowbeck Wood
Lidsing
Lidsing Court Farm
Abbey Court Farm
Broadview Farm
Huntfield House
Woodside Cottage
Charles Dickens Lodge
Rochester Business Park
Stoke
Elspeth
Rosebury House
Villa Nova
Mill House
Dunn Street
Manor Farm
Stockings Meadow
Sandpits
Industrial Estate
Junior School
Path
Track
Ditch
Stone
Well
Garage
Greenhouses
Pond
Tumulus
Telephone Kiosk
Post Box
Sub Station
Pylon
Church
Tower
Ruins
Quarry
Orchard
Vineyard
Nursery
Allotments
Sewage Works
Refuse Tip
Boundary Stone
Milestone
Milepost
Cattle Grid
Level Crossing
Footbridge
Bridge
Tunnel
Embankment
Cutting
Spoil Heap
Shaft
Adit
Battery
Mast
Flagpole
Aerial
Radio Mast
Wind Pump
Windmill
Water Tower
Gas Holder
Gas Governor
Oil Tank
Oil Well
Coal Mine
Slag Heap
Slag Tip
Sand Pit
Clay Pit
Gravel Pit
Chalk Pit
Mineral Working
Rock
Scrub
Heath
Marsh
Reeds
Sand
Shingle
Foreshore
Mud
Sea Wall
Groyne
Breakwater
Jetty
Pier
Slipway
Lighthouse
Beacon
Buoy
Boat Moorings
Boat Yard
Boat Shed
Boat Hoist
Boat Repair Shop
Boat Store
Boat Building Shop
Boat Sales
Boat Fuel Station
Boat Pump Out
Boat Chandlery
Boat Club
Boat Ramp
Boat Trailer Park
Boat Trailer Park
Boat Trailer Park